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UCSD NANOENGINEERING SEMINAR

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Seminar Presentation: 11:00am – 12:00pm

Cymer Conference Center

New Approaches for Exploiting III-V Compound Semiconductors in Photovoltaic and Photoelectrochemical Solar Energy Conversion

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Abstract:
Due to their highly favorable materials properties such as direct bandgap, appropriate bandgap energy against solar spectrum, and high electron mobilities, epitaxially grown IIIV compound semiconductors have provided unmatched performance in solar energy harvesting. However, their large-scale deployment in terrestrial photovoltaics and solar fuel generation remains as a daunting challenge primarily due to the prohibitively high cost of growing device-quality epitaxial materials. In this regard, unconventional ways to exploit IIIV compound semiconductors can create novel engineering designs, device functionalities, and cost structures, each with significant values in the next generation solar energy conversion technologies. In the first part of my talk, I will provide an overview of recent advances in materials design and fabrication strategies towards cost-efficient III-V photovoltaic systems based on multilayer-grown, ultrathin, nanostructured GaAs solar cells. Hexagonally periodic TiO2 nanoposts directly implemented on the window layer of GaAs solar cells served as a lossless diffractive coating for antireflection, diffraction, and light trapping in conjunction with a co-integrated back-surface reflectors, providing 16.2% onesun efficiency with solar cells that have the thickness of active layer (emitter + base) more than 10 times thinner than conventional devices. In the second part, I will present a type of integrated III-V photoelectrode system for solar fuel generation based on printed assemblies of epitaxially grown compound semiconductors. Specialized epitaxial design together with a bi-directional electrode configuration enabled independent control and optimization of light absorption, carrier transport, charge transfer, and materials stability of GaAs-based photoelectrodes. These advantages synergistically contributed to the 13.2% solar-tohydrogen efficiency of unassisted-mode water splitting under AM1.5G illumination using a series-connected wireless tandem system of GaAs photoelectrodes.

Biosketch:
Dr. Jongseung Yoon is an Assistant Professor in the Mork Family Department of Chemical Engineering and Materials Science at the University of Southern California. He received a Ph.D. degree in Materials Science and Engineering from MIT in 2006, and B.S. degree in Polymer Science from Seoul National University in 1996, respectively. Prior to joining USC, Prof. Yoon was a Beckman Institute Postdoctoral Fellow at the University of Illinois at Urbana-Champaign. His current research focuses on tailoring and understanding novel electrical, optical, electrochemical, and thermal properties of nanostructured inorganic single-crystalline semiconductor materials and exploiting them as synergistic materials building blocks into unusual format device implementation in areas ranging from photovoltaics, photoelectrochemical solar fuel generation, to flexible/stretchable optoelectronics for skin-mountable/implantable sensing and therapeutic systems. Prof. Yoon received the DARPA Young Faculty Award in 2012 and Hanwha Non-Tenure Faculty Award (Korea) in 2015.